Kimberlite Ascent

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Kimberlite magmas derive from ultra-deep (≥200 km) mantle sources and transport high loads (>25 vol. %) of dense, mantle-derived xenoliths and xenocrysts to the Earth's surface. A distinctive trait of kimberlite is the high abundance of ellipsoidal-shaped xenocrystic olivine grains derived from disaggregation of mantle peridotite.

The exsolution of volatiles (CO_2 & H_2O) is generally used to provide the requisite buoyancy for these magmas to ascend continuously and rapidly. However, the *source* of volatiles and the physical-chemical process behind their liberation is rarely specified. Russell et al. (2012) provided a simple but unique model for the rapid ascent of these enigmatic magmas involving deep-seated fluid production driven by preferential assimilation of orthopyroxene by parental carbonatitic to carbonate-rich silica-undersaturated melts [1].

Here we expand on this model using evidence embedded in morphological (rounding) [2,3], textural (sealed and healed cracks) [2], and surface (smooth and flakey) [3] properties of xenocrystic olivine. These features record physical and chemical changes attending kimberlite ascent and elucidate the physical nature of transport for the kimberlite magma.

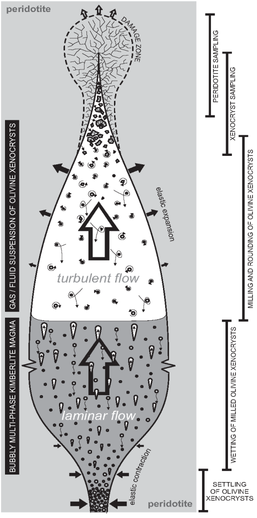

Fig. 1. Architecture of kimberlite factory. The factory is an elastically-inflated portion of the kimberlite dyke. Upper portion (white) comprises a turbulent, CO_2-rich fluid suspension of olivine xenocrysts sampled from the damage zone formed at the crack tip during dyke propagation. Grey region is a transitional to laminar flow regime comprising, frothy to bubbly kimberlite melt and xenocrysts sedimented from the overlying turbulent column of fluid.

[1] Russell *et al* (2012) *Nature* **481**, 352–356. [2] Brett (2009) Unpublished M.Sc. Thesis. [3] Jones *et al* (In Review) *Solid Earth*.